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Chapter 1 Notes – Science Skills

What is Science? – Section 1.1

Read Pages 2-6 in order to complete the reading guide and answer the questions.

Science involves asking questions about nature and then finding ways to answer them. This process doesn't happen by itself – it is driven by the curiosity of scientists.

Science from Curiosity

___________________ is a system of knowledge and the methods you use to find that knowledge. Science Begins with ____________________ and often ends with ____________________________. Curiosity provides questions but is seldom enough to achieve scientific results. Methods such as _____________________ and ________________________ provide ways to find the answers. In some experiments, observations are __________________________, or descriptive. In others, they are _____________________________, or numerical.

- **What is science?**____
- **What is the basis of science?**____

Science and Technology

As scientific knowledge is discovered, it can be applied in ways that improve the lives of people. ______________________ is the use of knowledge to solve practical problems. While the foal of science is to _______________ knowledge, the goal of technology is to ______________ that knowledge.

Science and technology are ____________________________. Advances in one can lead to advances in the other.

- **How are science and technology related? ______________________________________**

  ____

Branches of Science

The study of science is divided into social science and natural science. Natural science is generally divided into three branches: ________________ ________________, ______________ _______ ______________ ___________________, and ____________ ___________________. Each of these branches can be further divided.

Physical science covers a broad range of study that focuses on _____________________ ____________. The two main areas of physical science are chemistry and physics. _______________________ is the study of the composition, structure, properties, and reactions of matter. _________________________ is the study of matter and energy and the interactions between the two through forces and motion.

Comprehension Questions

1. How does the scientific process start and end?

2. Explain the advantages and disadvantages of subdividing science into many different areas.

3. Why do scientists seek to discover new laws of the universe?

Matching

4. ______science	A) study of the origin, history, and structure of Earth
5. ______technology	B) study of the universe beyond Earth
6. ______chemistry	C) system of knowledge and the methods used to find it
7. ______physics	D) study of living things
8. ______geology	E) use of knowledge to solve practical problems
9. ______astronomy	F) study of the composition, structure, properties, and reactions of matter
10.______biology	G) study of matter and energy and their interactions

Using a Scientific Approach – Section 1.2

Read Pages 7-11 in order to complete the reading guide and answer the questions.

Scientific Methods

In order to answer questions about the world around them, scientists need to get information. An organized plan for gathering, organizing, and communicating information is called a _____________________ ______________________. Despite the name, a scientific method can be used by anyone, including __________________. All you need is a ________________ to use it. The goal of any scientific method is to ________________ ___ _____________________ or to better understand an ____________________ ________________.

- **What is a scientific method?** ____
  ____

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Making Observations

Scientific investigations often begin with observations. An ______________________ is information that you obtain through your __________________. Repeatable observations are known as _______________. For example, when you walk or run in the rain, you get wet. Standing in the rain leaves you much wetter than walking or running in the rain. You might combine these ______________________ into a ____________________: How does your speed affect how wet you get when you are caught in the rain?

- **What is an observation?** ____
  ____

Forming a Hypothesis

A _________________________ is a proposed answer to a question. To answer the question raised by your observation about traveling in the rain, you might guess that the faster your speed, the drier you will stay in the rain. What can you do with your ___________________? For a hypothesis to be _________________, it must be ___________________.

- **What is a hypothesis?** ____
  ____

Testing a Hypothesis

Scientists perform ____________________ to ___________ their hypotheses. In an experiment, any factor that can change is called a __________________. Suppose you do an experiment to test if speed affects how wet you get in the rain. The variables will include your speed, your size, the rate of rainfall, and the amount of water that hits you.

Your hypothesis states that _________ _________________, speed, causes a change in _________________ __________________, the amount of water that hits you. The speed with which you walk or run is the _____________________ variable (***dependent***), or the variable that causes a change in another. The amount of water that you accumulate is the __________________ variable (***independent***), or the variable that changes in response to the manipulated variable. To examine the relationship between a manipulated variable and a responding variable, scientists use ____________________ ____________________. A controlled experiment is an experiment in which only __________ ______________________, the manipulated variable, is ______________________ changed at a time. While the responding variable is observed for changes, all other variables are kept ____________________.

- **How do you make a controlled experiment?** ____________________________________
  ____

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Drawing Conclusions

Based on their data, the scientists concluded that running in the rain keeps you drier than walking – about 40 percent drier, in fact. Now you have scientific __________________ to ________________ the hypothesis stated earlier.

What happens if the data do not support the hypothesis? In such a case, a scientist can ____________ the hypothesis or _______________ a new one, based on the __________ from the experiment. A new experiment must then be designed to test the revised or new hypothesis.

Developing a Theory

Once a hypothesis has been ___________________ in ______________________ experiments, scientists can begin to ________________ ____ _________________. A scientific theory is a well-tested _____________________ for a set of observations or experimental results. For example, according to the kinetic theory of matter, all particles of matter are in constant motion. Kinetic theory explains a wide range of observations, such as ice melting or the pressure of a gas.

Theories are never ______________. Instead, they become stronger if the facts continue to explain new facts and discoveries, the theory may be revised or a new theory may replace it.

- **What happens if new facts are unexplained by a theory?________________________**
  ____

Scientific Laws

After repeated observations or experiments, scientists may arrive at a __________________ ________. A scientific law is a statement that _____________________ ____ ________________ found in nature. For example, Newton's law of gravity describes how two objects attract each other by means of a gravitational force. This law has been ______________ over and over. However, scientists have yet to agree on a theory that explains how gravity works. A scientific law describes an _________________ ______________ in nature without attempting to ______________ it. The explanation of such a pattern is provided by a scientific theory.

- **What is the difference between a scientific theory and a scientific law?____________**
  ____
  ____

Scientific Models

If you have ever been lost in a city, you know that a street map can help you find your location. A street map is a type of model, or _________________________, of an object or event. Scientific models make it easier to understand things that might be too difficult to _______________ _______________. As long as a model lets you _________________ ________________ what is supposed to be represented then the model has done its job.

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An example of a mental, rather than physical, model might be that comets are like giant snowballs, primarily made of ice. Scientists would __________ this model through __________________, experiments, and calculations. Possibly they would even send a space probe – a visit to a comet really is planned! If all of these tests ________________ the idea that comets are made of ice, then the model of icy comets will continue to be believed.

However, if the data show that this model is wrong, then it must either be _________________ or be ___________________ by a new model. If scientists never challenged old models, then nothing new would be learned, and we would still believe what we believed hundreds of years ago. Science works by _________________ _________________. The fact that newer models are continually replacing old models is a sign that new _____________________ are continually occurring. As the knowledge that makes up science keeps changing, scientists develop a better and better ________________________ of the _________________.

<u>Comprehension Questions</u>

1. What is the goal of scientific methods?

2. Why are scientific models useful?

3. What are three types of variables in a controlled experiment?

4. Does every scientific method begin with an observation? Explain.

Matching

5. ______scientific method	A) statement that summarizes a pattern found in nature
6. ______observation	B) variable that changes in response to the manipulated variable
7. ______hypothesis	C) experiment in which only one variable is deliberately changed
8. ______manipulated variable	D) an organized plan for gathering, organizing, and communicating information
9. ______responding variable	E) the variable that causes a change in another
10.______controlled experiment	F) representation of an object or event
11.______scientific theory	G) information you obtain through your senses
12.______scientific law	H) well tested explanation for a set of observations
13.______model	I) proposed answer to a question

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Section 1.3 Notes - Measurement

Read Pages 14 – 20 in order to complete the reading guide and answer the questions.

How old are you? How tall are you? The answers to these questions are measurements. Measurements are important in both science and everyday life. Hardly a day passes without the need for you to measure amounts of money or the passage of time. It would be difficult to imagine doing science without any measurements.

Using Scientific Notation

Scientists often work with very large or very small ______________________. For example, the speed of light is about 300,000,000 meters per second. On the other hand, an average snail has been clocked at a speed of only 0.00086 meter per second.

Instead of having to write out all the _________________ in these numbers, you can use a _____________________called scientific notation. _________________________ _____________________ is a way of expressing a value as the __________________ of a number between _____ and ________ and a power of 10. For example, the number 300,000,000 written in scientific notation is 3.0×10^8. The ____________________, 8, tells you that the decimal point is really 8 places to the ___________ of the 3.

For numbers ____________ than 1 that are in scientific notation, the __________________ is _________________________. For example, the number 0.00086 written in scientific notation is 8.6×10^{-4}. The ____________________ exponent tells you how many _____________________ ____________________ there are to the ________________ of the 8.6. Scientific notation makes very large or very small numbers ____________________ to work with.

SI Units of Measurement

For a measurement to make sense, it requires both a number and a _____________. For example, if you told one of your friends that you had finished a homework assignment "in five," what would your friend think? Would it be five minutes or five hours? Maybe it was a long assignment, and you actually meant five days. Or maybe you meant that you wrote five pages. You should always ______________ measurements in _____________________ and ____________ so that their meaning is clear.

Many of the units you are familiar with, such as inches, feet, and degrees Fahrenheit, are not units that are used in ___________________. Scientists use a set of measuring units called ____, or the International System of Units. The abbreviation stands for the French name *Systeme International d'Unites*. SI is a revised ________________ of the ________________ system, which was originally developed in France in 1791. By adhering to one system of units, scientists can readily __________________ one another's ________________________________.

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Base Units and Derived Units

SI is built upon _______________ metric units, known as ___________ units, which are listed in the figure below. In SI, the base unit for _______________, or the straight-line distance between two points, is the ______________ (m). The base unit for _____________, or the quantity of matter in an object or sample, is the ____________________ (kg).

Additional SI units, called ____________________ units, are made from ____________________ of ___________ units. The figure below lists some common derived units. For example, _________________ is the amount of space taken up by an object. The volume of a rectangular box equals its ______________ times its _________________ times its __________________. Each of these dimensions can be measured in meters, so you can derive the SI unit for volume by multiplying meters by meters by meters, which gives you ______________ ______________ (m^3).

SI Base Units		
Quantity	**Unit**	**Symbol**
Length	Meter	M
Mass	Kilogram	Kg
Temperature	Kelvin	K
Time	Second	S
Amount of Substance	Mole	mol
Electric current	Ampere	A
Luminous intensity	Candela	cd

Derived Units		
Quantity	**Unit**	**Symbol**
Area	Square meter	M^2
Volume	Cubic meter	M^3
Density	Kilograms per cubic meter	Kg/m^3
Pressure	Pascal ($kg/m*s^2$)	Pa
Energy	Joule ($kg*m^2/s^2$)	J
Frequency	Hertz (1/s)	Hz
Electric charge	Coulomb (A*s)	C

Another quantity that requires a derived unit is density. __________________ is the ratio of an object's _______________ to its _______________.

Density = Mass/Volume

To derive the SI unit for density, you can _________________ the base unit for ___________ by the _________________ unit for __________________. Dividing kilograms by cubic meters yields the SI unit for density, kilograms per cubic meter (kg/m^3).

Metric Prefixes

The metric unit for a given quantity is not always a _______________________ one to use. For example, the time it takes for a computer hard drive to read or write data – also known as the seek time – is in the range of _________________________ of a second. A typical seek time might be 0.009 second. This can be written in a more compact way by using a ______________ _______________. A metric prefix indicates how many times a unit should be _________________ or ____________________ by _______.

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The figure below shows some common metric prefixes. Using the prefix *milli-* (m), you can write 0.009 second as 9 milliseconds, or 9 ms.

9 ms = 9/1000 s = 0.009 s

Note that dividing by _________________ is the same as multiplying by _________________.

Metric prefixes can also make a unit _______________. For example, a distance of 12,000 meters can also be written as 12 kilometers.

12 km = 12 x 1000 m = 12,000 m

Metric prefixes turn up in _________________________ units as well. If you work with computers, you probably know that a gigabyte of data refers to 1,000,000,000 bytes. A megapixel is 1,000,000 pixels.

SI Prefixes			
Prefix	**Symbol**	**Meaning**	**Multiply Unit by**
Giga-	G	Billion (10^9)	1,000,000,000
Mega-	M	Million (10^6)	1,000,000
Kilo-	k	Thousand (10^3)	1,000
Deci-	d	Tenth (10^{-1})	0.1
Centi-	c	Hundredth (10^{-2})	0.01
Milli-	m	Thousandth (10^{-3})	0.001
Micro-	µ	Millionth (10^{-6})	0.000001
Nano-	n	Billionth (10^{-9})	0.000000001

The easiest way ________________ from one unit of ______________________ to another is to use ______________________ ___________________. A conversion factor is a ____________ of _____________________ measurements that is used to convert a quantity expressed in one unit to __________________ unit. Suppose you want to convert the height of Mount Everest, 8848 meters, into kilometers. Based on the prefix *kilo-*, you know that 1 kilometer is 1000 meters. This ratio gives you two possible conversion factors.

1km/1000m   1000m/1 km

Since you are converting from meters to kilometers, the number should get _________________. Multiplying by the conversion factor on the left yields a smaller number.

8848 x (1km/1000m) = 8.848 km

Notice that the meter units _________________, leaving you with kilometers (the larger unit).

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To convert 8.848 kilometers back into meters, multiply by the conversion factor on the right. Since you are converting from kilometers to meters, the number should get __________________.

$$8.848 \text{ km} \times (1000\text{m}/1\text{km}) = 8848 \text{ m}$$

In this case, the kilometer units cancel, leaving you with meters.

Limits of Measurement

Suppose you wanted to measure how much time it takes for you to eat your breakfast. You could use two different clocks – an analog clock and a digital clock. The analog clock displays time to the nearest minute. The digital clock displays time to the nearest second (or one sixtieth of a minute). Which clock would you choose?

Precision

The digital clock offers more precision. _____________________ is a gauge of how ______________ a measurement is. According to the analog clock, it might take you 5 minutes to eat your breakfast. Using the digital clock, however, you might measure 5 minutes and 15 seconds, or 5.25 minutes. The second ________________________ has more significant figures. ____________________ ___________________ are all the____________ that are _____________ in a measurement, plus the __________ digit that is __________________. The time recorded as 5.25 minutes has three significant figures. The time recorded as 5 minutes has one significant figure. The _____________ the significant figures, the less ______________ the measurement is.

When you make calculations with measurements, the ____________________ of the separate measurements must be correctly ________________ in the final ______________. The precision of a calculated answer is________________ by the ___________ precise measurement used in the ____________________. So if the least precise measurement in your calculation has two significant figures, then your calculated answer can have at most two significant figures.

Suppose you measure the mass of a piece of iron to be 34.73 grams on an electronic balance. You then measure the volume to be 4.42 cubic centimeters. What is the density of the iron?

$$\text{Density} = 34.73\text{g}/4.42 \text{ cm}^3 = 7.857466 \text{ g/cm}^3$$

Your answer should have only ____________ significant figures because the _____________ precise measurement, the volume, has ______________ significant figures. Rounding your answer to three significant figures gives you a density of 7.86 grams per cubic centimeter.

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Accuracy

Another important quality in a measurement is its accuracy. ___________________ is the ____________________ of a measurement to the ___________ value of what is being measured. For example, suppose the digital clock is running 15 minutes slow. Although the clock would remain precise to the nearest second, the time displayed would not be accurate.

Measuring Temperature

A____________________ is an instrument that measures ___________________, or how hot an object is.

The two temperature scales that you are probably most familiar with are the __________________ scale and the ______________ scale. On the Fahrenheit scale, water freezes at 32°F and boils at 212°F at sea level. On the Celsius (or ________________) scale, water freezes at _________ and boils at ___________. A degree Celsius is almost twice as large as a degree Fahrenheit. There is also a difference of 32 degrees between the zero point of the Celsius scale and the zero point of the Fahrenheit scale. You can ____________ from one scale to the other by using one of the following formulas.

$$°C = 5/9\ (°F - 32.0°) \qquad °F = 9/5\ (°C) + 32.0°$$

The SI base unit for temperature is the _______________ (K). A temperature of _____ K, or 0 kelvin, refers to the _____________ possible temperature that can be reached. In degrees Celsius, this temperature is -273.15°C. To _____________ between kelvins and degrees Celsius, use the following formula.

$$K = °C + 273$$

The figure below compares some common temperatures expressed in degrees Celsius, degrees Fahrenheit, and kelvins.

Common Temperatures			
	Fahrenheight (°F)	**Celcius (°C)**	**Kelvin (K)**
Water boils	212	100	373
Human body	98.6	37	310
Average room	68	20	293
Water freezes	32	0	273

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Comprehension Questions

1. Why do scientists use scientific notation?

2. What system of units do scientists use for measurements?

3. How does the precision of measurements affect the precision of scientific calculations?

4. List the SI units for mass, length, and temperature.

5. A bulb thermometer gives an indoor temperature reading of 21°C. A digital thermometer in the same room gives a reading of 20.7°C. Which device is more precise? Explain

6. Convert -11°F into degrees Celcius, and then into kelvins.

Matching

7. ______scientific notation	A) the ratio of an object's mass to its volume
8. ______length	B) ratio of equivalent measurements that is used to convert a quantity expressed in one unit to another unit
9. ______mass	C) way of expressing a value as the product of a number between 1 and 10 and a power of 10
10. ______volume	D) straight-line distance between two points
11. ______density	E) gauge of how exact a measurement is
12.______conversion factor	F) amount of space taken up by an object
13.______precision	G) all the digits that are known in a measurement, plus the last digit that is estimated
14.______significant figures	H) quantity of matter in an object or sample
15.______accuracy	I) instrument that measures temperature
16.______thermometer	J) the closeness of a measurement to the actual value of what is being measured